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ELECTRIC LIGHT & POWER

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VOICE OF THE ELECTRIC UTILITY INDUSTRY

LATE NEWS

Snake River sockeye salmon was proposed "endangered;" public comment is due June 4. This and other protections may cut Northwest hydro power and hike rates.
A KPL/KG&E merger would not save money, said Kansas and Missouri regulatory staff, in recommending denial of the action.
Tri-State G&T's plan for acquiring Colorado-Ute Electric Association includes lower rates than the PS of Colorado/PacifiCorp plan.
The 1500-MW Summit pumped storage independent power project (p.12,3/91) was OK'd April 12.

Line failures darken Oahu

850,000 in a 12-hr outage; crowded beaches

Mark T. Hoske
News Editor

HONOLULU—Multiple transmission failures led to a 12-hr blackout April 9 on Oahu, served by Hawaiian Electric Co. Inc. (HECo). About 850,000 residents spent the day without power—the first total blackout since 1983. The main island has 250,000 meters.

Chris Shirai, HECo manager of system operations, explained. One of four 138-kV lines was deenergized at 7:55 a.m. for scheduled structural maintenance. At 8:23 a.m. a second line faulted on a tree and tripped. The system held stable as designed until 8:33 when a third line tripped for reasons currently being investigated. Overloaded, the final line tripped, starting an imbalance that shut down two plants and darkened the entire island by 9:07. Honolulu is the largest load center served by the big 643-MW oil-fired Kahe Power Plant, located 26 miles west of the city.

HECo started restoration in stages at 10:50 a.m. All circuits were fed and most customers restored by 8:26 p.m., but isolated outages persisted into April 10. Most businesses let out for at least an afternoon, some people spent time trapped in elevators and traffic was tight without signals. Officials encouraged people to stay off the streets and cut water use, if possible. More people than usual took to the beaches. Widespread food waste was expected from lack of refrigeration.

HECo officials said it would pay for damages if lack of "reasonable diligence and care" caused the outage. The Hawaii Public Utilities Commission also is investigating, noted Administrative Director Henry Tsuyemura, April 10.

"At this time, we don't know what might have contributed," he said. Rooting out causes and looking at system reliability could take months, he added.

EPA may have found economical solution to PCB disposal problem

Wayne Beaty
Senior Editor-Transmission/Distribution

CHICAGO—The Environmental Protection Agency (EPA) may have accidentally discovered a safe and inexpensive way to destroy large amounts of polychlorinated biphenyls (PCBs).

EPA and others continue to research the discovery, first reported in 1987, but not widely discussed.

Then, EPA workers cleaning up an oil refinery in Indiana added quicklime to PCB-contaminated sludge to thicken it and make it easier to transport and burn. "When we came back a few months later to take samples, we couldn't find the PCBs anymore," explained Robert J. Bowden, chief of EPA's regional emergency-response branch in Chicago.

The PCBs in most samples had been reduced to a mere five parts per million from about 2000 ppm—low enough not to pose a threat to people. "In one batch, there were none," Bowden said. "This discovery could have enormous implications. Based on our research so far, it's very, very promising."

He said a similar effect has since been recorded at two other EPA cleanup sites. In addition, chemists at RMC Environmental & Analytical Laboratories in West Plains, MO, were hired to conduct independent tests that replicated the results.

The RMC tests started with samples using a synthetic soil matrix containing 4000 ppm PCBs. The tests isolated quicklime as the ingredient responsible for the destruction of the organic chlorine compounds within about 96 hrs. RMC

Continued on page 4

ELECTRICITY PRICES

U.S. Cents per Kilowatthour

	1988	1989	4Q89
North America			
United States*	5.29	7.64	7.56
Canada	2.9	4.8	4.9
Western Europe			
France	11.5	'88=13.1	NA
West Germany	10.0	14.2	14.8
Italy	7.1	12.5	13.3
United Kingdom	8.8	9.6	9.7
Sweden	5.9	6.6	6.8
Netherlands	11.5	'88=10.9	NA
Far East			
Australia	4.6	6.8	6.8
Japan	11.8	18.7	18.0

Note: 1988 figures given when 1989 was not available (NA). * Excluding taxes.
Source: Energy Information Administration/ International Energy Annual 1989, (available March 1,1991)

"See story p.3"

Air Quality Accord tightens Canada rules

OTTAWA—As part of the Canada-United States Air Quality Accord, Canada committed to adopt more stringent air regulation.

The agreement, signed on March 13 by President George Bush and Prime Minister Brian Mulroney, binds both countries to implement current air policies, and establishes a bilateral Air Quality Committee. The committee, in part, will address transboundary issues (*EL&P*, 4/91, p.1).

Eliminates 'acid-rain menace'

"With this agreement and with the control programs now in effect in both countries," explained the Prime Minister at the signing, "we are confident that the acid-rain menace will be eliminated by the year 2000."

"Beyond our common interest in our shared environment," added the President, "this agreement says something about our overall relationship. The fact that Canada and the United States were able so quickly to craft a wide-ranging and effective agreement on such a complex subject says a lot about the extraordinarily strong relationship between

Continued on page 12

Ice storm devastates North-central Indiana grid

PLAINFIELD, IN—PSI Energy Inc. system suffered the majority of utility damage from the March 12-13 ice storm. More than 200,000 customers lost power at various utilities; nearly half the losses were at PSI.

The state of Indiana sought and received federal disaster aid for 19 counties; 8 of those were in PSI territory. Within PSI territory, damages were spread over 15 counties. Power was restored to all PSI customers after 15 days. North-central Indiana may be cleaning up for four months, sources say. Parts of Illinois south of Chicago also were affected by the same ice storm.

Other utilities affected included Northern Indiana Public Service Co., Indiana Michigan Power (AEP), Commonwealth Edison Co., and municipal systems in Tipton and Frankfort, IN, as well as rural electric cooperatives.

Steve Fischer, PSI Energy's executive director, distribution engineering and operations, called damage, from the ice and fallen trees, "massive destruction."

The storm, in PSI Energy territory alone, took out about 3500 power delivery structures, more than 100 miles of line, including 37.6 miles of 230-kV

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The March 12-13 ice storm took out more than 3500 poles and towers in PSI Energy area alone.

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NEWS BRIEFS

JILL MINNER, Special Projects Editor

INPO gives ComEd's Braidwood top rating

The Institute of Nuclear Power Operations (INPO) has awarded Commonwealth Edison Co.'s Braidwood Generating Station an overall excellent performance, rating, Category 1, according to the utility. INPO recognized Braidwood for its team-building, aggressive problem-solving, radiation protection programs and innovative use of electronic data processing programs. Areas reviewed by INPO were: maintenance, operations, training, engineering support, radiation protection, chemistry, organization and administration, and operating experience. See related stories, p.3, 16.

UE&C opens regional headquarters in SC

United Engineers & Constructors Inc. (UE&C) said it has established a new regional management office in Greenville, SC, to direct the operations of its offices in Chattanooga, Kingsport, and Knoxville, TN, and in Winston-Salem, NC.

"We've been doing projects in the south for sixty years, and we've had offices in the region for some twenty years. As our business in the region continues to grow, we believe a strong commitment in terms of regional managment and control is certainly appropriate," explained UE&C President and CEO Charles Q. Miller.

ConEd uses coupons to educate customers about conservation

Consolidated Edison Co. of New York Inc. is encouraging residential customers to visit its conservation center by giving away compact fluorescent light bulbs. As part of its Enlightened Energy program, the utility sent customers gift certificates redeemable at the center for a free fluorescent bulb.

"The compact bulb offer was designed to provide our customers a worthwhile service while testing whether they would be willing to take time to visit the conservation center to obtain the $20-value fluorescent bulb. The response we have seen is encouraging," said Dennis P. Quirk, Con Edison vice president for energy services. Con Ed reported that so far more than 50,000 people have visited the center to collect the fluorescent bulbs.

Con Ed's program is intended to lower usage of electricity in New York City and Westchester County by as much as 15 percent by the year 2008. The fluorescent bulbs use about 75 percent less electricity and last approximately 10 times longer than standard incandescent bulbs, according to the utility.

Personnel briefs

John C. Brons has been appointed president and chief operating officer of the **New York Power Authority**. Brons, formerly executive vice president-nuclear generation, succeeds Phillip Bayne, who resigned to become president and CEO of the U.S. Council for Energy Awareness.

Madison Gas and Electric Co. has proposed that President and Chief Operating Officer Frank C. Vondrasek take over as chairman and chief executive officer when Donald J. Helfrecht retires Sept. 30, 1991. The utility also proposed that David C. Mebane, senior vice president and general counsel, fill the position of president and chief operating officer. The moves require MG&E board approval.

United Illuminating Co. President and Chief Operating Officer Richard J. Grossi has been chosen to replace George W. Edwards Jr. as chairman and chief executive officer of the utility. Edwards resigned from his position at UI to head Kansas City Southern Railway Company. Robert L. Fiscus will succeed Grossi as president and continue to serve as chief financial officer.

After a reorganization of its operating divisions on April 1, **Metropolitan Edison Co.** named Joseph B. DeAngelo to head its new Western Region and Carole B. Snyder to head the new Eastern Region.

Cooling Tower Institute's new chairman and president is Robert J. Cunningham, president of Chemisis Inc.

National Association of Corrosion Engineers president is William F. Gundaker, director of corrosion engineering at Ebasco Services Inc.

Retired Detroit Edison Chairman and CEO Walter J. McCarthy Jr. is again chairman of the **Institute of Nuclear Power Operations**.

Met-Ed welcome packet informs new customers

Metropolitan Edison Co. said it is now distributing a "welcome packet" to new customers. The packet provides information on payment programs, energy conservation programs, service interruption procedures, safety tips and advice on how to choose energy-efficient appliances. It also includes a postage-paid card for use in ordering a variety of free materials, according to the utility.

ABB forms Va. division

Asea Brown Boveri has announced the formation of ABB Power Generation's Manufacturing Division in Richmond, VA. According to the company, the new division is responsible for the components, assembly and installation services involved with ABB gas and steam turbine products for delivery in North America.

ABB said the plant, which incorporates one of the world's largest gas and steam turbine test facilities, serves ABB Energy Service Inc. and ABB Steam Power Generation Co. Thomas Astrom has been appointed vice president in charge of the new manufacturing division.

NU reaches hydro production record

Northeast Utilities reported that during 1990, above-average rainfall in southern New England boosted its hydroelectric production to a record one-billion kWh.

The output was 31 percent above average and 23 percent above the 958-million kWh recorded in 1989, according to NU. "The extra rainfall translates directly into customer savings because while we must pay for the oil, the water comes free," noted Ronald G. Chevalier, superintendent of the utility's hydroelectric facilities.

NU has 23 conventional hydroelectric sites, 14 in Massachusetts and 9 in Connecticut.

Old Consumers Power plant hits milestone

According to Consumers Power Co., its 28-year-old Big Rock Point nuclear plant has reached a lifetime net electrical output of 10-million MWh. "This production record is a major milestone for the little engine that could," said William L. Beckman, manager of the plant.

Big Rock Point, the fifth commercial nuclear plant to be constructed in the U.S., was built small to meet the needs of the U.S. Atomic Energy Commission. Consumers Power said the 67-MW plant required less fuel for tests and was less expensive and more flexible to operate than a large unit would have been. "The continued strong performance of a plant built at the dawn of the nuclear age is a great source of pride to all of us who work here," Beckman added.

Only one unit still in operation, the Yankee nuclear plant, is older than Big Rock Point, according to the utility.

APPA honors utilities for safety practices

The American Public Power Association recently presented 55 electric utilities with its 1990 Electric Utility Safety Award, at the association's Engineering & Operations Workshop in Orlando, FL.

The 193 utilities that entered were judged according to their size for the most incident-free records during 1990. Of the 55 award winners, 38 had perfect records, according to APPA.

Utilities fined by NRC

The U.S. Nuclear Regulatory Commission reported that it recently proposed the following fines:

Entergy Operations Inc.
A $37,500 fine for failure to assure the proper functioning of a safety-related system at the Waterford Steam Electric Station. The system protects control room operators from outside radiation and toxic-gas releases during an accident by monitoring the atmospheric pressure inside the control room.

Indiana Michigan Power Co.
A $150,000 fine for a violation of NRC fire protection requirements in a design modification at the D.C. Cook nuclear power station.

Northeast Nuclear Energy Co.
A $37,500 fine for alleged violations of technical specifications involving the service water system at Millstone Unit 2.

Nuclear Fuel Services
A $10,000 fine for alleged violation of NRC requirements at the company's nuclear fuel processing facility. The violation involved the transfer of radioactive liquid in amounts above procedural limits set to prevent accidental criticality.

Portland General Electric Co.
A $50,000 fine for alleged violations of NRC requirements involving medical records of licensed reactor operators at the Trojan Nuclear Plant.

Wolf Creek Nuclear Operating Corp.
A $25,000 fine for operating the Wolf Creek nuclear plant with inoperable emergency cooling pumps for at least 12 hours before the problem was discovered.

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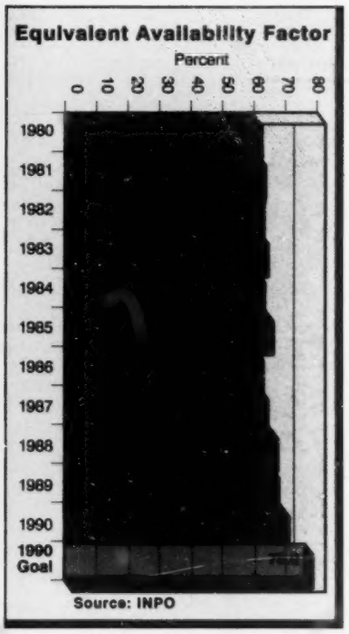
Coming next month:
EL&P's 26th Annual
Top 100 Report

INPO helps nuclear units surpass some '90 goals

ATLANTA—The nuclear industry improved in eight of nine performance areas in 1990, according to the Institute of Nuclear Power Operations.

Of nine 1990 goals set in 1986, five were surpassed, but four of those already had been reached in 1989. Equally aggressive goals will be set for 1995, INPO said in its annual report.

Collective radiation exposure per PWR unit increased to 294 man-rem per unit, up from 292 in 1989, and short of the 1990 goal of 288. It's down significantly, however, from a 10-year high of 707 in 1981.



Goals surpassed

Indicators passing 1990 goals were:

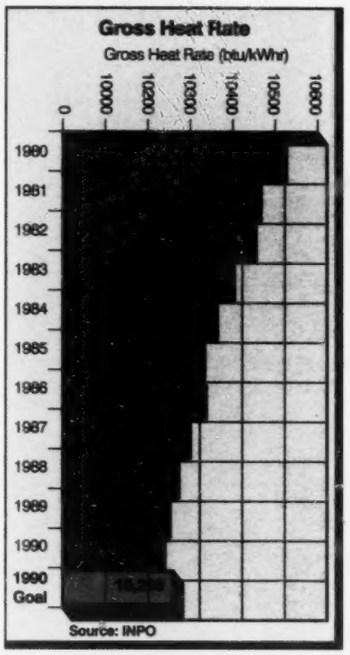
- Gross heat rate (see table).
- Unplanned safety system actuations, 0.7 per unit, down from 0.9 and surpassing the goal of 0.8.
- Collective radiation exposure per BWR unit dropped to 436 man-rems per unit, down from 442, and 511 in the two previous years, better than the target of 469.
- Low-level solid radioactive waste (BWR) was 301 m^3 per unit, well below the 466 goal, which was beaten in '87.
- Low-level solid radioactive waste (PWR) was 108 m^3 per unit, almost half of the 218 goal. In 1980, it was 586.

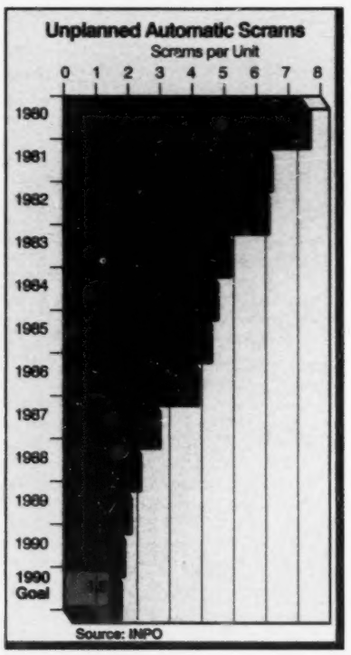
Missed goals

Indicators missing 1990 goals were:

- Equivalent availability factor and unplanned automatic scrams (tables).
- PWR radiation exposure (above).
- Lost-time accident rate, 0.22 per 200,000 man-hours worked, above the 0.19 goal, but down from a 10-year high of 1.36 in 1980.

INPO was formed by nuclear utilities to improve the safety, reliability and operations of nuclear plants.





North America generates most; Japan pays the most, 18.7¢/kWh

WASHINGTON—World total net electricity generation was 10.5-trillion kWh in 1988, with North American using the most, 32 percent of the total, according to the most-recent figures released by the Department of Energy's Energy Information Administration.

The U.S. generated the most, 2.78-trillion kWh of the 3.38-trillion kWh for North America.

Also in 1988, Western Europe produced 21 percent of the total; Eastern Europe and USSR, 20 percent; the Far East and Oceania, 19 percent; Central and South America, Africa, and the Middle East, each less than 5 percent of total 1988 generation.

Electricity prices in 1989 for selected countries (p.1 table), were lowest for Canada at 4.8¢/kWh and highest for Japan at 18.7¢/kWh.

World generating mix in 1988, the most recent figures available, was 63 percent thermal, 20 percent hydro, 17 percent nuclear, and less than 1 percent geothermal. Thermal was counted as coal, oil and gas. Geothermal includes other sources: solar, biomass, wind and other renewables.

Energy figures for more than 190 countries are available in EIA's "International Energy Annual, 1989," dated February 1991 and available since March 1. *Contact the U.S. Government Printing Office, Washington, DC 20402, 202/783-3238.*

SVC engineer/developer honored

STOCKHOLM, Sweden—The Swedish Association of Graduate Engineers has awarded the Polhem Gold Medal to Harry Frank, Asea Brown Boveri, for his contributions to the development of the thyristor-controlled static var compensator (SVC).

The SVC is a device that increases the reliability of modern power transmission systems by stabilizing the voltage where the supply system is subject to large load variations. It substantially reduces the capital costs to operate such systems by making it possible to increase the load on existing systems by supplying reactive power and quickly control it so that a network can be more efficiently utilized.

Once considered exotic technology, Frank's enthusiastic and reliable technical concepts succeeded in its development. To date, over 100 compensators valued at $440 million have been supplied to utilities worldwide.

The Polhem Gold Medal was instituted in 1876 to commemorate Christopher Polhem, 1665-1771, a Swedish inventor, engineer and industrialist.

Idaho beefs up energy theft program

BOISE, ID—Idaho Power investigated 238 cases of actual or suspected energy diversion in 1990, an increase of 83 over 1989. Bob Smith, IP's energy diversion specialist says, "The number of cases investigated has increased nearly fourfold in the last three years, but the company has beefed up its detection and prosecution efforts."

IP recovers about 82 percent of theft-related expenses. Cliff Harris, the company's metering specialist responsible for administering and reporting, noted the company has added a computerized program last year which greatly enhanced its ability to track violators as they move around to different parts of the company's service territory.

EC countries are expanding electric capacity but face U.S.-type problems

WASHINGTON—The 12 countries making up the European Community (EC) face the same problems as U.S. electric utilities, problems such as varying fossil fuel costs and supplies, environmental concerns, policy questions and continued uncertainty among the public about nuclear power. But they are proceeding to plan and/or build 180 new power plants of over 100 MW.

The total amount of new capacity to be added, 66.6 GW, is approximately 12 percent of current installed EC capacity. The power will come mainly from coal (36 percent of the total capacity), natural gas (26 percent), nuclear (16 percent), hydroelectric (14 percent), and oil (5 percent), according to a report from the Utility Data Institute.

By 1992, when the 12 nations will be an integrated economy, they probably will control about 16 percent of the world's generating capacity, or about 450 GW.

Utilities and non-utility generators have approximately 5500 units installed now. Of this number, NUGs (called *autoproducers* in the EC) generated about 40 GW in 1988, the most recent figures UDI has. Overall installed capacity was approximately 449.8 GW.

Unlike conditions in the U.S., NUG contributions to overall EC capacity have been declining in recent years. From 1985 to 1988, EC NUG capacity went down by about 1 GW.

In Belgium, a typical example, NUGs represented 10.5 percent of installed capacity in '76, but only 5 percent in '88, dropping from 1.2 to 0.7 GW.

Two EC nations are the exceptions. A new market for utility-scale independent power producers and cogenerators is developing in Great Britain since the breakup of the government-owned Central Electricity Generating Board. And in the Netherlands, NUG capacity increased about 18 percent from 1985 to 1988.

The report, Directory of Power Plants in the European Community, *is available for $395 from: Utility Data Institute, 1700 K St., NW, Suite 400, Washington, DC 20006; 202/466-3660.*

On the matter of energy policy, the European Community (EC) has its energy trade zone plan.

The EC Commission of the European Communities (Eurecom) adopted a draft charter for an energy trade zone extending from the Atlantic Ocean to the Ural Mountains. The Eurecom plan would commit signatories to a free market in energy, covering access to and exploitation of energy resources, common investment rules, shared research and development, safety norms and environmental standards.

The proposed charter has to be approved by EC governments before an international conference could be called to discuss the details and ratify them.

Under the proposed plan, Western European countries would be able to trade investment in technology, technical expertise and infrastruture improvements for some of the Soviet Union's energy resources.

EC Energy Commissioner Antonio Cardoso E Cunha warned that the charter's success depended heavily on political conditions, particularly those between the EC and the Soviet Union.

The move is in addition to EC energy objectives promulgated in the spring of 1985 set to be in effect by 1995. Among the objectives were:

- Improve final energy demand efficiency by at least 20 percent.
- Reduce oil consumption to 40 percent of overall energy consumption.
- Increase solid fuels' share of consumption.
- Reduce electricity generated from oil and gas to under 15 percent.
- Substantially increase output from new and renewable energy sources.

Unfortunately, a followon review of these objectives by the commission concluded:

- Energy efficiency probably would not reach the 20-percent figure.
- Oil consumption would only drop to about 43 percent of overall energy consumption.
- Solid fuel usage would probably increase.
- The share of oil and gas used for electricity generation would drop to about 15 percent.
- Renewables could represent 2 percent of the total energy balance.

Further plans and actions are under review by Eurecom.

COMMENTARY

Canada/U.S. clean-air accord

At long last, the U.S. and Canada have agreed to clean up the air...on both sides of the border. As reported in our p.1 story, U.S. and Canadian negotiators have successfully completed an accord that calls on both nations to begin now to clean up air polution on a timetable running through 2010.

The agreement has been a long time in coming. First efforts were launched under the Carter Administration and renewed under the Reagan Administration. Charges of transborder pollution of Canadian air by [largely] Midwest utilities and large industrial plants were levied on U.S. negotiators. During those years, while Canada, and its Eastern provinces, pointed fingers of guilt at U.S. utilities, virtually no Canadian emission controls were applied. U.S. utilities installed scrubbers and other stack gas cleaning systems, and switched to low-sulfur coal in order to reduce sulfur emission levels, but Canadian utilities built not one scrubber or other stack gas cleaning system. Canadian stacks poured out SO_2 and NOx, unhampered.

The current accord, signed by Prime Minister Brian Mulroney and President Bush, marks a new level of statemanship. Both nations admit responsibilities and agree to deal with them. No finger pointing. No histrionics. No "holier than thou" accusations. Once again, the two nations that share the world's longest undefended border, similar standards of living and a language, have proven the power of shared common interest. The politicians have done their best. Now it's time for engineers to get on with the job that must be done.

Robert A. Lincicome, Editor-in-Chief

Three skills needed

Effective managers excel in certain skills. Three of those skills are avoiding crisis, making valid comparisons, and taking action. Employing these skills can help in almost any job, and government is no exception:

•*Avoid crisis.* Congress, the administration, democrats and republicans all deserve acclaim for resolving the recent crisis related to the railroad strike. They recognized the nature of the emerging crisis and its potential effect, prepared for it, built concensus, then waited to see if opposing sides would agree. Just 18 hours after the strike was announced, Washington averted what could have become national chaos. Amazingly, when something *really* mattered, political posturing and power brokering fell away, and the goal was accomplished. Washington proved it could act to avoid crisis...a great performance.

•*Make valid comparisons.* Is it valid to compare the performance of government and elected representatives to other organizations, free-enterprise businesses or our own work efforts? What if your company kept running in the red? What if budgets were normally submitted late...and unbalanced? What if people in your organization forgot their promises? What if they avoided risk, market opportunities, and actions of conscience and substance for fear of offending anyone?

The answers? We would be fired and/or our organizations would become non-competitive. Markets, revenues and services would decline and eventually such organizations would fold. But government seems to flourish under such conditions.

•*Take action.* The skillful leader or manager *acts*, not merely *reacts*, and is compensated for success. But Congress? Different criteria seem to apply when we decide who is compensated with our vote. Despite general discontent with Congress as a whole last fall, we reelected most incumbents handily.

This time around, we would hope that you follow closely what your elected representatives do for you, your organizations and your country. Watch C-Span, follow the news, read *EL&P*. Write letters. Ask hard questions of your representative on positions taken on issues and voting. Keep files of what your government does, or doesn't do, both for you and *to* you.

Then, if performances are business-as-usual, *USE* these three valuable skills yourself: (1) avoid crisis by (2) making valid comparisons of how things have been and should be done, then (3) take action: vote the rascals out of office.

Mark T. Hoske, News Editor

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LETTERS

Archeology and utilities

For a century, the practice of American archeology has been dominated by university programs. Battalions of summer diggers have mobilized annually to satisfy research models crafted by an elite cadre of university professors. The specific interests of academia have dictated which sites would be uncovered by spade and trowel. This special-interest group, until recently, dictated the major content of our nation's historical record.

Congressional passage of the Historic Preservation Act of 1966, while designed to protect antiquities, also opened the door for private sector entry into archaeological research. The Act, along with subsequent amendments, states that "the historical amd cultural foundations of the Nation should be preserved as a living part of our community life and development in order to give a sense of orientation to the American people." This federal response was engendered by a realization that twentieth century progress—in larger, thirst-quenching dams and longer powerline extensions—threatened to pave over, inundate or span vast chapters of the American story.

As you are well aware, this act has forced utility companies to "look below their feet" before adding new line extensions. An expanded market for archeological services has set the stage for private sector firms to compete with universities for cultural resource projects. Federal legislation has created ironic situations in the field of archeology. While construction projects destroy many historical sites in their path, private sector scientists are able to study a broader spectrum of sites that may never have been investigated by university organizations. Therefore, this new work is adding to a wider knowledge of our history.

Private sector firms, unlike many university organizations, understand the realities of business. They realize that cost conscious utility managers do not enjoy budgeting for cultural resources work. Private-sector archeologists, therefore, provide mandated services in a competitive, treamlined and cost-effective manner. As business people themselves, they are driven by the same economic realities that affect their clients. [These] private sector archeology firms can allow little quarter for dilettante, repetitive research.

Art Christensen
Consultant
Alburquerque, NM

Editor's note: Utility managers are far more concerned about such things as preservation of historical artifacts, than opponents—or reader Christensen—like to admit. But more cost-effective archeological preservationefforts as offered by private-sector organizations, as suggested, certainly should make future utility cooperation even easier to obtain.

Clarification, correction

The Mihama nuclear accident story (3/91, p.1) should have said, "...released trace amounts of radioactive substances...." To clarify, nuclear radiation is particles or energy emitted by atoms undergoing radioactive decay. A curie is a unit expressing the rate of radioactive decay.

The city of Charleston referred to (4/91, p.12) is, of course, in South Carolina, not North Carolina.

from page 1

PCB disposal solution...

also found that trace levels of certain contaminant metals in the quicklime work as catalysts in the vigorous chemical reaction that destroys the toxic material and leaves only three relatively safe byproducts—calcium chloride, water and carbon dioxide.

Details of the process at RMC are not available because the firm has filed for patent protection.

More research needed

The process is still relatively unknown outside EPA. Daniel Abramowicz, manager of environmental technology at General Electric, says he does not yet know the technical details of the process, but speculates it might be similar to GE experiments using potassium hydroxide for chemical destruction of PCBs.

Chemical Waste Management, a Chicago-based firm, is one of many looking into the process. George Vander Velde, vice president for science and technology, was quoted in Chemical & Engineering News (Mar. 18, 1991, p. 5) as saying, "Base-catalyzed dechlorination is a known phenomenon and we have such a process. But it is used in liquids, not solids. This is because EPA regulations require that PCBs concentrated greater than 500 ppm be incinerated and not stabilized, so there has not been much work done there."

Velde said Chemical Waste Management will try to duplicate EPA's results, making sure that quicklime's high heat of hydration doesn't just disperse PCBs into the air and that no hazardous byproducts are formed.

The EPA says its own laboratory in Cincinnati will begin further research, and a formal report is expected after those tests are completed. Work so far has not been subjected to peer review, and no formal report has been published in an authoritative journal.

Donald T. Sawyer, a chemist at Texas A&M University who has done extensive research on PCBs says, "I don't think enough research has been done to really be sure. Detecting the disappearance of PCBs is easy, but proving that all the chlorine became calcium chloride is difficult. Are the PCBs destroyed or just changed into molecules that are equally toxic?"

EPA's Bowden says the quicklime method costs substantially less than incineration, the most widespread and controversial method of PCB disposal. Incinerating a cubic yard of PCB-contaminated material can cost more than $500, the quicklime technique appears to cost only about $75.

The safety and cost issues of PCBs have spurred several efforts to find alternatives. For example, GE has worked with biotechnology companies to speed up "bioremediation" of a contaminated 40-mile stretch of New York's Hudson River.

The EPA said that there are indications the lime treatment may also work on other toxins such as dioxin and strong pesticides.

Firms that specialize in transformer oil-recovery systems for electric utilities are keeping a close eye on the process, but most see the process as more applicable to "superfund" toxic remediation systems than to the electric utility industry. One reviewer commented, "I wonder if this 'discovery' might be the 'cold-fusion' for PCBs?"

Meeting environmental concerns—

Does the future belong to fossil fuels?

Henry Stein
Senior Editor—Generation

Focus
Fossil Fuels

From all appearances, fossil fuels will not only remain the mainstay for this country's electric power generation, but will grow in importance, at least for the next 15-20 years.

U.S. industry (including electric utilities) has already spent more than $250 billion to reduce air emissions since the Clean Air Act was passed in 1970, according to several estimates. And that's just for starters.

Since 1975, electric utilities in this country have spent more than $100 billion just to reduce SO_2 emissions, with an annual average of $8 billion spent by coal-burning utilities alone to comply with air quality standards, notes the U.S. Department of Energy.

It's working

Results? All U.S. manmade sulfur-dioxide emissions have declined dramatically (Fig. 1), dropping by 28-30 percent between 1970 and 1988. Yet during the same period, U.S. electric utilities increased coal usage by 80 percent (highly important, since more than half the electricity generated here, 56 percent, is produced by burning coal). The decline in emissions is mainly attributed to switching to lower-sulfur coals, installing flue-gas desulfurization (FGD) systems, and cutting down on use of high-emitting plants.

In a more recent report, the EPA listed trends observed for the decade of 1980-1989 (inclusive) as reductions of:

- Twenty-four percent in SO_2 ambient levels.
- Five percent in NO_2 levels.
- Twenty-five percent in CO_2.
- Eighty percent in lead.

Now the Clean Air Act Amendments (CAAA) of 1990 require that utilities must reduce SO_2 emissions even more, to 50 percent of their 1980 levels by year 2000 and then be "capped" at that level, approximately 8.9-million tons per year.

Nitrogen-oxide emissions must be reduced to 2-million tons per year less than 1980 levels (Fig. 2).

In addition, President Bush's National Energy Strategy (NES) calls for changing the fuel mix for generating electricity and reducing fuel demand by about 7 quads by 2030 (Fig. 3).

The three main fossil fuel sources are coal, natural gas and oil.

A unit train is loaded with "ultralow-sulfur" coal at a Sidney Coal Co. Inc. preparation center near the mine in Pike County, KY, with coal-handling facilities and preparation plant in the background. Two-thirds of the 3.5-million tons of coal produced per year here burns with less than 1 lb/MMBtu of SO_2 emissions. The preparation center shipping capacity is 10,000 tons/day; its storage capacity is 80,000 tons. (Photo courtesy of Massey Coal Co.)

Coal

Electric power plants consume more than 85 percent of the coal used in the U.S. They produce more than 56 percent of the country's electrical energy in about 500 of the approximately 3000 power plants here. DOE predicts coal will be used to generate over 60 percent of the electricity by year 2010.

Because of this heavy usage, the NES promotes the Clean Coal Technologies (CCT) heavily by calling for their further development and new demonstration projects. It also recommends:

- Providing regulatory incentives to offset financial risks in commercial deployment of CCT.
- Allowing power plants maximum flexibility in complying with the CAAA.
- Reducing cost, investment risks and environmental impacts of producing liquid fuels from coal.
- Working much harder on reducing carbon dioxide emissions associated with burning coal.

Coal is the nation's most abundant fossil energy resource—proved coal reserves are the largest in the world. Major coal deposits are located throughout the country, with heaviest concentrations in the Southeast, Midwest and West. The eastern and midwestern states contain mainly bituminous coal; the western states, concentrations of bituminous and subbituminous coals and lignite.

Reducing emissions

Strategies for reducing emissions fall into three stages—precombustion, combustion and postcombustion.

Precombustion Stage: Plants can switch to lower-sulfur coals, natural gas or oils, or physically, chemically or biologically clean the coal by removing pollutants before it is burned. Another option is cofiring coal, and gas or oil, depending on their availability and cost. And interest is growing again in still another option, gasifying the coal and burning the product.

Combustion Stage: Coal burning can be modified, pollutant-absorbing substances can be injected into the combustion chamber, or the process itself can be changed to fluidized-bed combustion.

Postcombustion Stage: Devices can be installed to remove pollutants from the flue gases leaving the boiler.

Among the postcombustion systems are: particulate control systems, which include electrostatic precipitators and fabric filters; FGDs, which include wet and dry scrubbers, and ductwork sorbent injection; and various NOx reduction systems.

When selecting an FGD method, Black & Veatch stresses consideration must be given to the space requirements of the system, disposal requirements for material created by scrubbers, need for a reagent chemical, and designs, operations and costs of the systems.

And, says David G. Arey, assistant director at Southern Illinois University's Coal Research Center, "Scrubbers work, but they are energy consumers, not generators. Scrubbers often use 5 to 10 percent of a power plant's total energy requirements."

The firm's suggestions for repowering options include fluidized-bed combustors, combustion turbines with heat-recovery steam generators or coal gasification.

Compliance strategies

John M. Wooten, vice president-Engineering & Operations Services for Peabody Development Co., recommends a seven-step compliance strategy decison-making process:

1. Identify affected units.
2. Determine amount of allocated allowances.
3. Compute allowable SO_2 emission rate.
4. Investigate compliance options.
5. Determine fuel supply contractual obligations.
6. Select a compliance strategy.
7. Obtain approval for compliance strategy.

Identifying the units is easy. For Phase I of CAAA, an affected utility generating unit is one that is 100 MW or larger and has a 1985 SO_2 emission rate greater than 2.5 lb/MMBtu. For Phase II, it is any unit with a capacity greater than 25 MW that sells one-third or more of its electrical output.

EPA estimated approximately 265 units in 110 plants in 21 eastern and midwestern states would be affected by the Phase I rule.

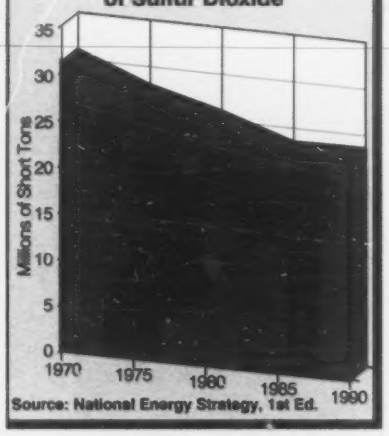
Formulas can be used to determine individual unit reductions, but then there are exceptions and special factors that must be applied, so it is advisable to work with someone thoroughly familiar with the amendments to determine the units that are affected and how much each reduction must be. The same applies to emission rates.

Wooten suggests compliance options to consider are fuel switching or blending, SO_2 removal systems, trading allowances between units, and purchasing someone else's allowances. Black & Veatch adds unit repowering and operation modification to his list.

When considering fuel switching, Wooten says the plant operator should determine contractual obligations for

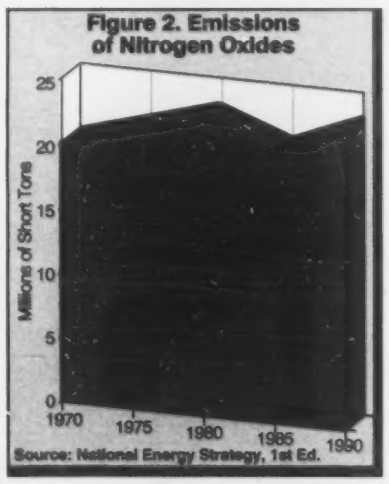
Continued on page 28

Figure 1. Emissions of Sulfur Dioxide



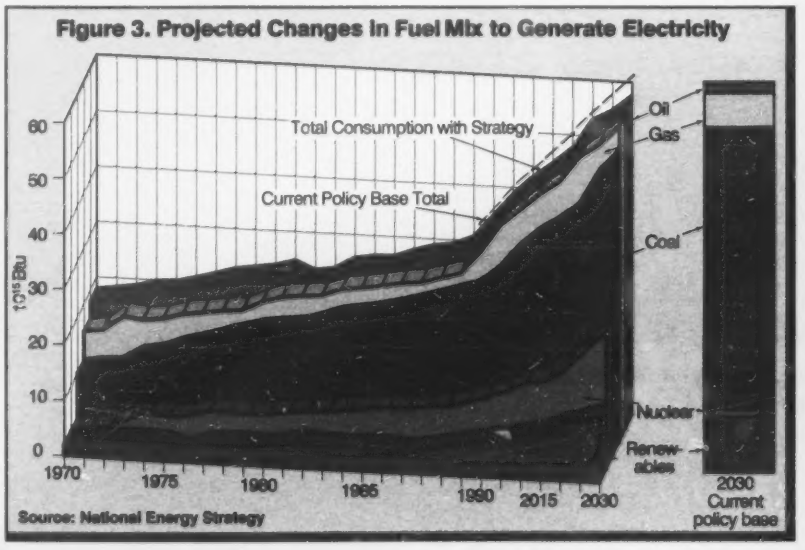
Source: National Energy Strategy, 1st Ed.

Figure 2. Emissions of Nitrogen Oxides



Source: National Energy Strategy, 1st Ed.

Figure 3. Projected Changes in Fuel Mix to Generate Electricity



Source: National Energy Strategy

fuel supply contracts in terms of both *force majeure* clauses and the right of substitution.

The sixth step, selecting a compliance strategy, involves both operational and economic considerations. Operational considerations include fuel receiving and handling, boiler configurations, fuel quality, particulate and NOx controls, and plant configuration. Economics, of course, includes taking into account both capital and operating costs.

Lastly, approvals must be obtained from both the EPA and state public utility commission.

Phase I vs. Phase II

Thomas S. Hilton Sr., vice president of Peabody, notes that in Phase I utilities may decide to switch to low-sulfur coals and thus generate excess emission allowances. The allowances could be sold or carried over into Phase II. Or, switching one unit to low-sulfur coal might provide enough excess to allow the system's remaining units to keep operating as-is.

However, Larry Metzroth of Resource Data International warns that switching coals involves more than just what goes out the stack. He lists other considerations that must be taken into account: delivered fuel price differential; precipitator efficiency; coal storage, handling and conveyance systems; coal pulverizing system; ash handling equipment and disposal; and derating costs.

In Phase II, Hilton feels very low-sulfur coal probably will be required to allow for systems' growth by year 2000. So, the very low-sulfur coals from the West may be the fuel of choice for many utilities.

He presents a few of his typical cases for different areas and conditions.

In his Eastern Coal Case, he suggests the possibility of switching to a low-sulfur bituminous coal with an SO_2 emission rate of 1.2 lb/MMBtu. His Western Coal Case relies on switching to a low-sulfur subbituminous coal with an SO_2 emission rate of 0.8 lb/MMBtu.

With plants that are reasonably close to one another, he suggests pairing them for operational, economic, contractual and/or political reasons. Then maximize the amount of high-sulfur coal that can be burned in one plant by switching the other to Powder River coal that has an SO_2 emission rate of 0.5 lb/MMBtu.

One utility's actions

In what is billed as the first major design, supply and construction contract directly resulting from the CAAA, Allegheny Power System (APS) signed with General Electric Environmental Systems to perform those duties in erecting three single-vessel FGD scrubbers and one three-flue, 1000-ft chimney at its Harrison Power Station near Clarksburg, WV. The $83-million contract is also called the first commercial contract for a utility-class, 100-percent capacity, single-tower wet FGD system in the U.S.

Site work is scheduled for the spring, with construction to begin in the fall. However, the contract is subject to change or cancellation if the APS compliance plan is not approved by the regulatory authorities.

The wet FGD systems are designed to remove 98 percent of the plant's SO_2 emissions.

A unique concept used on the project is installing one of the three absorber vessels inside the base of the new chimney—another first in the U.S.—which will further reduce space requirements and capital costs. GE installed a similar single-absorber vessel in the chimney at Stewag Mellach Station in Austria four years ago.

Start of scrubbers construction at the 1920-MW coal-fired plant is planned for this fall and will be managed by a subsidiary of United Engineers & Constructors Inc.

APS estimates it will spend about $800 million in capital costs for compliance activities. In addition to the $725 million for the three Harrison scrubbers, Phase I capital costs are to include more than $50 million for new NOx burners on boilers at four power stations and $25 million for continuous-emission monitors at 10 stations. Expected benefits include reduction of SO_2 emissions of at least 200,000 tons a year.

The company bases its compliance plan on engineering studies begun more than a year ago on how to most efficiently and economically reduce SO_2 and NOx emissions. The studies considered alternate compliance options, including several generating unit retirements or replacements, and adding fluidized-bed boilers, coal gasification and other technologies. Scrubbers and a switch to low-sulfur coal then got detailed technical, environmental and economic study.

For the Harrison plant, magnesium-enhanced lime scrubbing turned out to be the least-cost and best method to comply with Phase I of CAAA. And the method allows continued use of local coal, thus avoiding serious economic disruption and adverse socioeconomic effects that massive shifting to low-sulfur coal from outside the region would cause.

For Phase II, the experience gained at Harrison may be applied to the system's other generating stations, or they still might use fuel switching. Tentatively, scrubbers have been recommended for Hatfield's Ferry Power Station near Masontown, PA. Planned SO_2 emissions reductions total 193,000 tons a year for Phase II.

And what others are doing

The Southern Co. didn't wait for the "shoe to drop," either. Says Jim Stevenson, project manager for Clean Air Act compliance strategy at Southern Co. Services, "If we had, we'd be behind the eight ball right now. What we came up with should not only meet the goal of protecting the environment, but also minimize the cost to the company."

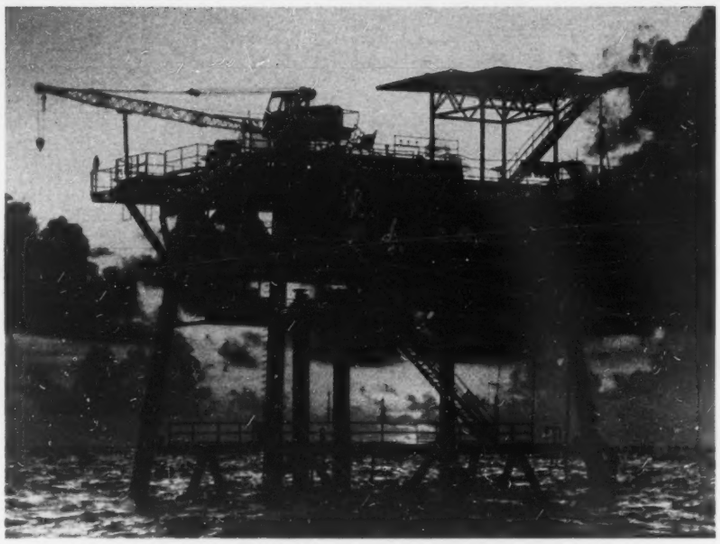
The emissions changes will cost the company up to $1 billion annually by year 2000. Most of the costs will be from reducing SO_2 and NOx at coal-fired plants throughout the Southern electric system.

Estimated compliance cost under Phase I is $30 million per year, which includes a one-time capital expense of over $100 million to modify precipitators to burn low-sulfur coal and to burn the low-sulfur coal at six plants.

For Phase II, the company forsees burning lower-sulfur coal at 11, or more, plants and installing scrubbers at up to seven plants.

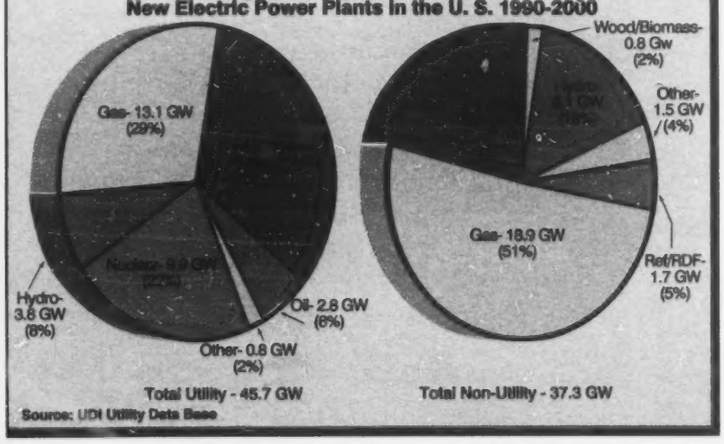
Projected SO_2 reduction costs under Phase II appear to be about $1 billion annually. That amount includes capital expenditures of over $3 billion.

The Phases I and II requirements for low-NOx burners are projected to cost the company $650 million.



Gas wells, too, are located offshore. This one draws natural gas from under the Gulf of Mexico and then pumps it ashore into the distribution system. (Photo courtesy of the American Gas Association)

Figure 4. Capacity by Fuel of New Electric Power Plants in the U. S. 1990-2000


Gas- 13.1 GW (29%)
Nuclear- 9.9 GW (22%)
Hydro- 3.8 GW (8%)
Oil- 2.8 GW (6%)
Other- 0.8 GW (2%)
Total Utility - 45.7 GW
Wood/Biomass- 0.8 Gw (2%)
Other- 1.5 GW (4%)
Gas- 18.9 GW (51%)
Ref/RDF- 1.7 GW (5%)
Total Non-Utility - 37.3 GW
Source: UDI Utility Data Base

Natural gas

Approximately one-fourth of the energy produced in the nation comes from natural gas. Reserves are spread, but appear in large concentrations, across the country. The fuel generally is transported by pipelines to consumers.

The NES recommends removing most regulations from the natural gas industry, the exceptions being where they are necessary to protect consumers. It also proposes to increase U.S. consumption by almost 1-trillion ft^3 (about 5 percent) over and above what consumption would be without NES policies. Specifically, NES recommends:

- Expediting natural gas pipeline construction.
- Streamlining the National Environmental Policy Act process associated with gas pipeline construction.
- Deregulating pipeline sales rates.
- Reforming pipeline rate design.
- Improving access to gas pipeline transportation services.
- Eliminating Dept. of Energy's import and export regulation.
- Encouraging use of natural gas as an alternative transportation fuel.

Importance of supplies

Gas production is expected to meet normal demand in the lower 48 states through 1991. But Calvin A. Kent, administrator of the Energy Information Administration (EIA), warns that adequate supplies will not be available after this year unless drilling is increased. Kent also warns that an exceptionally high peak day, even in 1991, along with weather-related problems, could cause temporary shortages similar to those experienced in the last week of December of '89.

He predicts gas price rises to between $1.84/$ft^3$ and $2.20/$ft^3$. The bright side to the increase is that combined with shrinking surpluses, it should spur gas drilling to meet demand.

Supplies may be tight, since one-third of new capacity scheduled by regulated electric utilities (about 13.1 GW) and one-half of new capacity currrently scheduled by non-utility producers (18.9 GW) are planned to burn natural gas to produce electricity. They will use gas turbine simple cycle and combined-cycle plants.

Says Liz Hannon, president of Utility Data Institute, where these figures originated, "In addition to natural gas plants, regulated utilities show 10 GW of nuclear power and 15 GW of coal scheduled for service between 1990 and the year 2000. However, with several exceptions, most of the coal and nuclear capacity has been under construction for many years and, strictly speaking, does not represent 'new' capacity." (See Fig. 4.)

The NOx problem, solutions

The primary pollutant of concern from gas turbines is oxides of nitrogen (NOx), which include NO and NO_2. Other pollutant emissions are carbon monoxide (CO), unburned hydrocarbons, oxides of sulfur (SO_2 and SO_3), and particulate matter.

SO_2, unburned hydrocarbons and particulates emissions generally are neglible when burning natural gas.

Gas turbines generate NOx by two methods—fixation of atmospheric nitrogen in the flame (thermal NOx) and conversion of nitrogen chemically bound in the gas (fuel-bound nitrogen), noted Marvin M. Schorr, senior environmental engineer for GE Industrial & Power Systems, at the March American Cogeneration Association meeting in Mesa, AZ.

He pointed out that most natural gases and light distillate oils have little or no fuel-bound nitrogen, so it normally is not a consideration. That leaves at-

Continued on page 30

mospheric nitrogen as the problem.

The *rate* of generation of thermal NOx is an exponential function of flame temperature, noted Schorr, while the *amount* generated is that exponential function of temperature but also a linear function of the time the gases remain at flame temperature.

Methods to control NOx emissions from gas turbines mainly include:

- Lowering combustor temperature at the front end with diluent injection (water or steam).
- Selective catalytic reduction (SCR), a back end exhaust gas cleanup technique.
- Dry low-NOx combustors, in which GE uses staged combustion and lean fuel-air mixtures.
- Catalytic combustion systems.

Diluent injection. Injected diluent provides a heat sink that lowers the combustion zone temperature. However, as NOx emissions are decreased by this method, the added diluent causes a decrease in thermodynamic efficiency of the process and reduces parts lives.

Whether to inject steam or water usually depends on economic, not technological, considerations—Is the steam more valuable for generating electric power or for controlling the NOx emissions?

Approximately 60-percent more steam than water is needed in a natural gas-fired turbine to reduce NOx to the same level. However, steam's impact on heat rate generally is less, and steam also has a smaller impact on pressure oscillations and CO emissions than water.

Selective catalytic reduction. In the SCR process, ammonia is injected into the gas turbine exhaust gas stream to react with NOx in the presence of a catalyst to form molecular nitrogen and water. The most common catalyst used is vanadium pentoxide.

The process can remove 80-90 percent of NOx, but it requires steam or water injection to remove most of the NOx before the SCR goes to work lowering NOx levels to less than 10 ppm.

The process works best in baseloaded, combined-cycle gas turbines burning natural gas. SCR cannot be used in simple-cycle configurations without a heat-recovery steam generator to control catalyst temperature.

Care must be taken to keep unreacted ammonia out of exhaust stack emissions (ammonia "slip"). Other associated concerns are catalyst life, and costs and environmental problems of getting rid of used catalyst.

Dry, low-NOx combustors. Several turbine manufacturers have come out with dry, low-NOx combustors. They operate without the heat rate penalty and added maintenance of water or steam injection, and without the high capital investment and potential operating problems of SCR. However, some are still under development, and those in the field do not have the track record of water and steam injection.

Workers ("roughnecks") prepare to change a drilling bit at an oil well in the Peruvian jungle. (Photo courtesy of Occidental Oil Corp.)

Oil

Currently more than 200 refineries in the U.S. have a combined capacity to produce almost 16-million bbl of refined petroleum products per day. However, domestic production of crude oil fell for the fifth consecutive year in 1990, to the lowest level in 25 years. Consequently, in 1989, the most recent year figures are available from the federal government, 42 percent of the country's crude was imported. The U.S. was a net oil exporter until 1948, when consumption exceeded supply for the first time.

The NES encourages the country to become less dependent on oil. It recommends:

- Reducing impacts of oil market disruptions by increasing production in countries outside the Persian Gulf.
- Improving emergency preparedness by expanding the strategic petroleum reserve.
- Diversifying transportation fuels.
- Increasing domestic production.

On the world scene, Kent of the EIA said in February that stocks of petroleum continued to be well above the average of the past four years, despite the Persian Gulf war. As of Dec. 31, 1990, worldwide commercial stocks of crude oil and petroleum products totalled about 4.7-billion bbl, which was 205-million bbl above the four-year average level of 4.5-billion bbl. And he added only 3.1-billion bbl were required to maintain minimum operating levels.

EIA attributed the high stock levels to:

- Lower-than-expected demand due to warm winter weather, low economic growth and conservation actions.
- Increased production by Saudi Arabia and other producing countries that more than offset the loss of 4.3-million bbl/day from Iraq and Kuwait.
- Buildup of producer stocks near consuming regions in response to uncertainties before the war started.

Meanwhile, despite the relatively low price of crude oil of late, EIA also predicted U.S. petroleum consumption would decline in 1991. The organization places the reasons for this reduction on the economic recession and efficiency improvements in key petroleum sectors. In fact, net imports of oil and oil products were almost flat in 1990—demand fell by 370,000 bbl/day, or 2.1 percent.

However, more than 60 percent of the oil burned in the country is used in transportation applications, not in electric utilities. They generated only 5.7 percent of their overall electric output from oil in 1989.

Also, the EIA prediction was made before the Soviet Union announced in March that it was cutting oil exports in half. The *Wall Street Journal* reported that at the start of 1990, production in the USSR was 11.9-million bbl/day. But it fell to 10.9-million bbl/day by the end of the year. Kenneth Miller of Pervin & Gertz, an energy consulting firm, said about 2.3-million bbl/day were being exported. For now, most of the drop is being made up by OPEC countries.

Consortium to develop variable-speed wind turbine

Henry Stein
Senior Editor-Generation

BARRINGTON—The viability of using wind to generate electricity has been proven—under certain circumstances—but its more widespread usage depends on developing the technology further. Here are some of the recent advances made toward achieving that aim.

Utilities cooperate

Niagara Mohawk Power Corp., Pacific Gas & Electric Co., the Electric Power Research Institute and U.S. Windpower Inc. joined in a consortium to develop a 33-m-diam, variable-speed wind turbine that should produce power at low cost and of good quality. The five-year development project will cost about $20 million.

"This is the first time an alliance has been formed between a major wind turbine manufacturer and utility users on the East and West coasts," explained Dr. Edgar DeMeo, EPRI program manager. Thus, "What's learned can more quickly be transferred between the manufacturer and the users."

The new machine is designed to capture more energy from the wind than other types by operating at variable rotor speeds and with power electronics to optimize energy caught at both low and high wind speeds. In addition, the electronic control system reduces stress on the components, which should increase the turbine's useful life.

A prototype turbine installed at Altamont Pass in California is demonstrating an ability to reduce costs and increase energy capture. Niagara Mohawk plans to test two of the advanced-design turbines at an eastern Lake Ontario site beginning in 1992—the exact site will be selected late this year.

Vendors competing

In the world market, Danish wind turbine manufacturer Vestas-DWT and Japanese turbine builder Mitsubishi Heavy Industries are competing for dominance of the large wind machine market, that is, those with blades of 75-ft (23-m) diam and larger.

Wind Energy Weekly reports that by September 1990, Vestas had installed 470 wind turbines with blade diameters greater than 23 m, and Mitsubishi planned to have 697 in place by year's end. On the other hand, Vestas planned to have 750 of one model alone operating by the end of 1991, while Mitsubishi was not expected to add a significant number of machines this year.

The next nearest competitor, noted the *Weekly*, was Dutch manufacturer Windmaster, with less than half the turbines of either of the other two, or approximately 320.

All three companies use variable-pitch, three-bladed machines that operate at fixed speeds.

Meanwhile, the Italian energy agency ENEA and the Italian state utility ENEL plan to conduct side-by-side tests at Alta Nurra on the island of Sardinia and in the Apennine Mountains. The agency and utility will put through their paces wind turbines from Wind Energy Group (British), Vestas, Riva Calzoni (Italian) and Aeritalia Medit (Italian).

BPA looks abroad

Bonneville Power Administration is taking another route. BPA engineers and U.S. Windpower representatives are studying Windpower's experience with wind turbines in, of all places, Inner Mongolia.

The company is testing solutions to cold weather operating problems. A previous test of a turbine chilled in a fish freezing locker showed up some of its low-temperature operation shortcomings. After revising the insulation and changing to a different oil, a unit was shipped to Mongolia for outdoor testing in the extreme conditions found there.

BPA's interest is in installing wind turbines in the Pacific Northwest, in particular in Idaho, Montana and Wyoming. The engineers are concerned that the power from turbines in those states be available at Northwest peak seasons, notes the *BPA Circuit*, the organization's periodical.

Mike Berger, BPA resource planner, is quoted in the monthly as saying, "We plan things over a 20-year span. One important reason [for our interest] may be that the Pacific Northwest Planning Council has included 400 average megawatts of wind power in their draft resource plan." And one of the concerns BPA has with large-scale wind power is that turbine blades and mechanisms may not be able to withstand the combination or powerful winds and freezing temperatures in the areas.

Storing the energy

In another related development, a zinc-bromine storage battery is being developed to provide backup power during windless periods or at night for wind, solar and other generating technologies. Developed by researchers at the State University of New York, Syracuse, and the Weizmann Institute in Israel, the battery is seen as an inexpensive device for large-scale energy-storage banks.

Energy efficiency, the amount of energy stored compared to the amount put in, approaches 81 percent. Hundreds of charge-discharge cycles have had no effect on battery performance, say the researchers.

A 1-cm thick cell with an electrode area of 0.1 m^2, storing 100 Wh of electricity and routinely delivering 10 A, is operating at the Weizmann Institute.

Lead-acid batteries are not the best solution to backup power for wind and solar applications, say those at SUNY and Weizmann. The cells must be able to withstand repetitive, near-complete discharge. This type action damages normal lead-acid cells severely, and specially designed deep-discharge units are too costly for the applications. In addition, there is concern about safe disposal of the large amounts of lead if lead-acid battery usage were expanded too much.

Institute Prof. Joost Manassen estimates the zinc-bromine battery will

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